DESIGN AND CONSTRUCTION OF A SOUND ACTIVATED SECURITY ALARM

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DEDICATION

I dedicate this project to my immediate family, which has stayed with me, all through my life.

DECLARATION

I, Ajibade Tunde, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

Ajibade Tunde	13/10/06 Date
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External Supervisor	Date

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As always the companionship of JB and Carlos was enough to carry me through many more of such exercises. So also was the distant love shown by Ibrahim and John.

The biggest 'thank you' goes to the Almighty God without whom nothing is possible.

ABSTRACT

The objective of this project is to produce a device, which will generate alarm signals for certain levels of sound input. Such a device will act as a security alarm in environments that are meant to be quiet. In such environments any sound generated will trigger the alarm. A very important feature of this project is that the sensitivity of the device to sound can be varied providing a wide range of applications. To detect sounds a unidirectional moving coil microphone was employed. The input signals are amplified and passed through an oscillator and mixer latch, which combine to produce a desired alarm output. After the hectic processes of design construction and rigorous testing a final product was arrived at which achieved the objectives of the project.

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CHAPTER 1

INTRODUCTION

The importance of security in our day-to-day life can never be over stressed. This is even more emphasized in the technological improvements in all spheres of life including breaking of security systems. Most cases of robbery and theft could be attributed to low or no security level. Sometimes a breach in considerable security systems could also assist intending offenders. The losses accrued as a result of these lapses could be of large proportions inflicting serious hardship on the victims. As a result huge sums of money are therefore spent in tightening up security around valuable possessions as well as developing and updating security devices to meet modern threats.

In the world today security devices come in different forms, with different configurations, and of varying complexity levels. They are however all bound by one basic concept. They consist of an input, a processing unit and the output. The input embodies transducers or sensors capable of electronically representing or defining the state of a position in a place. The transducers are of different varieties. Transducers are devices designed to convert one form of energy to another. The initial energy (input) could be in form of infrared radiation (heat energy), sound energy, light rays etc. The transducer in most cases converts to electrical energy. The detection of intrusion is achieved by the interruption or production of the forms of energy (input) stated above. Such detection goes along with a particular electrical signal. The signal is linked to an electronic processing unit for translation and specific response or output. This usually comes in audio and or light alarm. Some security systems go as far as generating a feedback action to attack the offenders. This action though as far as security systems are concerned is an act of self-defense.

This project is no exception as it follows the same trend. It is a **SOUND ACTIVATED SECURITY ALARM UNIT.** At the input is a sound transducer (usually a very sensitive microphone), which converts a specific level of sound energy into corresponding electrical signal. The signal is first amplified before being used to trigger both light and audio alarms.

The design incorporates quite simple and recent electronic components. A single integrated circuit (IC) is used to amplify the weak output generated by the microphone. Also a group of complementary metallic oxide semiconductor (CMOS) integrated circuits are used for logic control and a very important in the triggering on of the alarms. The alarms are powered by Metallic Oxide Semiconductor Field Effect Transistors (MOSFET) for a high degree of flexibility.

Noise radiation and false alarm pose great challenges in the design of the system as they could easily affect the output therefore reducing the reliability of the device. To minimize the effect of noise radiation passive filters are incorporated into the design. A provision is also made for adjusting the sensitivity to allow for considerable sound before the device responds.

This device is designed to excel in quiet environments where any considerable noise could well imply intrusion. It is thus suited for banks, supermarkets, stores, etc. which have sections that suit that description. Such environments are of low noise levels and the device would respond and trigger the alarms whenever the noise level goes considerably high (possibly due to forceful breaking and or intrusion).

The merits of this design are not far fetched. It is obvious from the design that low power consumption electronic devices are used and in limited number. This achieves great economy. Also limited or simple technical experience is required for the construction and operation of the device. However this device only acts as a security device where sound is involved. Its sensitivity also has to be carefully set to achieve the desired result and avoid false alarm.

CHAPTER 2

2.1 LITERATURE REVIEW

An American manufacturer, Edwin Holmes who manufactured hoop skirts in New England in the nineteenth century is credited with inventing the first burglar alarm. He had a number of other business interests as well, and by the early 1850s Holmes had become involved in the manufacture of electric alarms. He developed what can be considered the first electric home burglar alarm system: a bell that rang if a door or window was opened. His experience as a skirt-maker was useful in solving some of the technical problems involving electrical wire. He installed the first of his alarm systems in Boston on February 21, 1858.

The success of Edwin Holmes was limited due to the crude nature of the art of electronics at that time. All manners of such design were attributed to electromechanical technique. Electrical or electronic devices of that time were of low performance and reliability. But, their attempts were quite of great importance to the present development in electronic designs.

In late 50's, the invention of solid-state semiconductor devices in Bell Laboratories greatly increased the performance of electronics. One of the evident changes was the drop in overall cost or the increased economic importance of control and security devices.

It is quite clear that any form of alarm follows the principle of control; some is required to trigger the alarm on. The first record sound electronic control was in 1957 when a group of engineers developed the Zenith "Space Command," a wireless remote control using ultrasonic waves. High frequencies sound was used for controlling domestics electronics especially television. Later, that technology was provided for sound related security system.

2.2 THEORITICAL BACKGROUND

The project is based on the use of sound energy in activating an electric alarm. This is just one of the many methods of achieving one and the same aim.

The other useable mediums include:

i infra-red radiation

ii microwave

iii wire

iv laser

Of all, sound activation provides quite an economic method. It is really a passive design. The device only listens to surrounding sound. It involves no transmission. Sound is therefore of great importance to this particular chapter. Microphones are related to the subject in the sense that they serve as transducers that convert the sound into corresponding electric energy for useful operational aims.

2.2.1 Sound Energy

Sound is a disturbance of mechanical energy that propagates through matter as a wave. Humans perceive sound by the sense of hearing.

By sound, we commonly mean the vibrations that travel through air and can be heard by humans. However, scientists and engineers use a wider definition of sound that includes low and high frequency vibrations in air that cannot be heard, and vibrations that travel through all forms of matter, gases, liquids and solids. The matter that supports the sound is called the medium. Sound propagates as waves of alternating pressure, causing local regions of compression and refraction. Particles in the medium are displaced by the wave and oscillate.

As a wave, sound is characterized by the properties of waves including frequency, wavelength, period, amplitude and velocity or speed. The scientific study of sound is called acoustics.

Noise and sound often mean the same thing; when they differ, a noise is an unwanted sound. In science and engineering, noise is an undesirable component that obscures a signal.

Sound is perceived through the sense of hearing. Humans and many animals use their ears to hear sound, but loud sounds and low frequency sounds can be perceived by other parts of the body through the sense of touch. Sounds are used in several ways, most notably for communication through speech or, for example, music. Sound can also be used to acquire information about the surrounding environment in properties such as spatial characteristics and presence of other animals or objects. For example, bats use echolocation, ships and submarines use sonar, and humans can determine spatial information by the way in which they perceive sounds.

The range of frequencies that humans can hear is approximately between 20 Hz and 20,000 Hz. This range is by definition the audible spectrum, but some people (particularly women) can hear above 20,000 Hz. This range varies by individual and generally shrinks with age, mostly in the upper part of the spectrum. The ear is most sensitive to frequencies around 3,500 Hz. Sound above 20,000 Hz is known as ultrasound; sound below 20 Hz as infrasound.

The amplitude of a sound wave is specified in terms of its pressure. The human ear can detect sounds with a very wide range of amplitudes and a logarithmic decibel amplitude scale is used. The quietest sounds that humans can hear have an amplitude of approximately 20 μPa (micropascals) or a sound pressure level (SPL) of 0 dB re 20 μPa (often incorrectly abbreviated as 0 dB SPL). Prolonged exposure to a sound pressure level exceeding 85 dB can permanently damage the ear and sometimes resulting in tinnitus and hearing impairment. Sound levels in excess of 130nbsp; dB are considered upward of what the human ear can withstand and may result in serious pain and permanent damage. At very high amplitudes, sound waves exhibit non-linear effects including shock.

The project involves any form of sound energy that is capable of energizing a microphone .A particular response is achievable with a critical signal level from the transducer.

2.2.2 Microphone

A microphone, sometimes called a mic (pronounced "mike"), is a transducer that converts sound into an electrical signal. Microphones are used in many applications such as telephones, tape recorders, hearing aids, motion picture production, live and recorded audio engineering, in radio and television broadcasting ,and in computers for recording voice. The invention of a practical microphone was crucial to the early development of the telephone system. Emile Berliner invented the first microphone on March 4, 1877, but the first useful microphone was invented by Alexander Graham Bell. Many early developments in microphone design took place in Bell Laboratories

In all microphones, sound waves (sound pressure) are translated into mechanical vibrations in a thin, flexible diaphragm. These sound vibrations are then converted by various methods into an electrical signal which varies in voltage amplitude and frequency in an analog of the original sound. For this reason, a microphone is an acoustic wave to voltage modulation transducer.

2.2.3 Microphone varieties

In a capacitor microphone, also known as a condenser microphone, the diaphragm acts as one plate of a capacitor, and the vibrations produce changes in the distance between the plates. Since the plates are biased with a fixed charge, the voltage maintained across the capacitor plates changes with the vibrations in the air. Capacitor microphones can be expensive and require a supply. They are attributed to high-quality sound signal and are now the preferred choice in laboratory and studio recording applications. An electret microphone is a relatively new type of condenser microphone invented at Bell laboratories in 1962 by Gerhard Sessler and Jim West, and often simply called an electret microphone. An electret is a dielectric material that has been permanently electrically charged or polarized.

A dynamic microphone, a common type which is incorporated into the project, holds a small movable induction coil, positioned in the magnetic field of a permanent magnet, is attached to the diaphragm. When sound enters through the windscreen of the microphone, the sound wave vibrations move the diaphragm, when the diaphragm vibrates, the coil moves in the magnetic field, producing a varying current in the coil.

The principle is exactly the same as in a loudspeaker, only reversed. Dynamic microphones are robust, relatively inexpensive, and resistant to moisture, and for this reason they are widely used on-stage by singers. They tend to have a poor low-frequency response, which is advantageous for reducing handling noise as a vocal mic, but tends to exclude them from other uses. The device provides a suitable choice for the project in term of cost and performance.

2.3 THE PRINCIPLE OF OPERATION OF A TYPICAL SOUND ACTIVATED SECURITY ALARM

Sound activated alarm is mainly used for security purposes. An alarm is triggered on whenever an unacceptable sound or noise is detected. Therefore, it is applicable for expected silent locations, especially during night time. Any sound activated alarm requires a sound transducer to convert related sound energy into corresponding electric signal .The leading electric signal is weak and requires an audio amplifier for reasonable workable resulting signal .This signal is defined to interact with a logical circuit which consists of digital units. The logic circuit triggers on an alarm whenever a critical input level is detected. The alarm is held on through a latch or memory technique. So that, the cause of the alarm is assumed present despite the fact it is no more. The alarm is often manually or timed automatically triggered off based on complexity and usage.

CHAPTER 3

DESIGN AND CONSTRUCTION

3:1 INTRODUCTION

Like every engineering work this design consists of different sections working in harmony to produce a desired output. These different sections will be discussed according to their order of appearance in the functioning of the general circuit. To achieve a level of simplicity the general circuit will be split into 2 units:

The power supply unit

The alarm circuit

3.2 THE POWER SUPPLY UNIT

For this design and many others the operation of the power supply unit affects that of every other section in the design. This explains why it is being treated as a separate unit.

Below is the block diagram of the power supply unit.

From AC mains

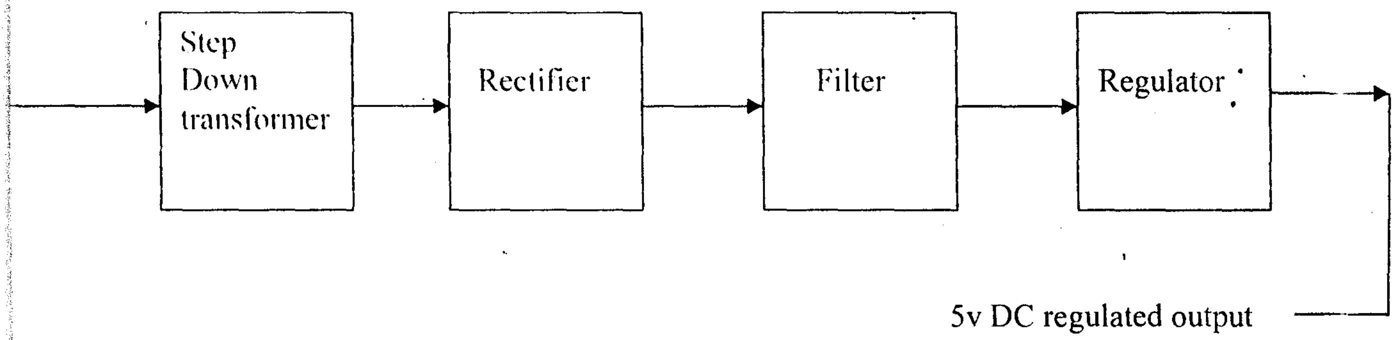


Fig.3.1 Block Diagram of the Power Supply Unit

Each section or sub unit of the power supply unit forms a block in the above diagram.

The first section in the operation of the power supply unit is the transformer, which receives a 220v supply from the AC mains. The transformer steps the voltage down to 12v before passing it on to the rectifier section. At the rectifier section the AC supply is rectified to DC with some high frequency components. At the filter section the high frequency components are filtered out leaving the DC components at the output of the filter. This filtered component then passes through the regulator, which keeps the output at a constant magnitude DC voltage (5v), which is fed to the alarm circuit as the power supply source. Each section or sub unit is further discussed in detail below.

3.2.1 Step down transformer: A transformer is a device consisting of two closely coupled coils (primary and secondary) with an AC voltage applied to the primary appearing at the secondary with a voltage multiplication proportional to the turns ratio of the transformer and a current multiplication inversely proportional to the turns ratio of the transformer and a current multiplication inversely proportional to the turns ratio. The following equation governs the operation of a transformer:

$$\frac{Ns}{Np} = \frac{Vs}{Vp} = \frac{Ip}{Is} \qquad \text{--------------3.1}$$

Where,

Ns = No. of secondary turns.

Np = No. of primary turns.

Vs = Voltage developed in secondary coil.

Vp = Voltage developed in primary coil.

Ip = Current developed in primary coil.

Is = Current developed in secondary coil.

In the operation described above power is conserved.

Due to the high efficiency of transformers (output power voltage very nearly equal to the input power) step up transformers give higher voltage at lower current. Also worthy of note, a transformer with turns ratio .n, increases the impedance by n square and there is very little primary current if the secondary is unloaded [1].

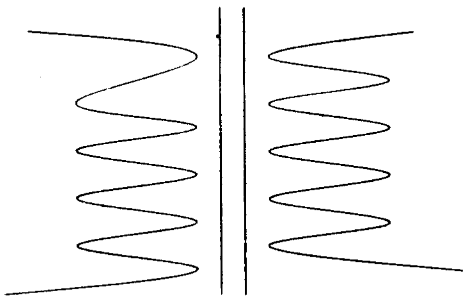


Fig.3.2 Transformer representation

The basic function of transformers in electronic circuits is that of changing the AC line voltage to a value useful for the circuit. They also isolate the electronic device from actual connection to the power line, because the windings of the transformer are electrically isolated from each other.

Power transformers (meant for use from 220v power line) come in enormous variety of secondary voltages ranging from 10 to 50volts with current rating of 0.1 to 5amps. The transformer chosen for this project is a 220/12v, 500mA step down transformer. This stems from the fact that certain components of the circuit use up to 12v.

3.2.2 The rectifier circuit: Rectification is the process whereby an ac voltage is converted to DC voltage. The circuit connection that does this is called a rectifier. This is one of the simplest and most important applications of diodes.

A bridge rectifier is employed for this design.

The IN4001 diode was chosen because it is very suitable for rectification purposes.

The function of this section is to rectify the AC input to DC though the output still contains some AC components.

3.2.3 The filter section: The filter is usually an electrolytic capacitor with a value enough to suppress the ripple voltage of the supply to the barest minimum.

Given the desired ripple voltage the following formula is used to calculate the capacitance of the capacitor:

$C = 1/(2*f*\Delta V)$ --------------------3.2

Where,

C = capacitance of the capacitor,

Δ V = ripple voltage.,

F = AC supply frequency (50Hz in this case).

The capacitor chosen should have a ripple voltage tolerance of at least 20% [1]. For this reason a 2200µF capacitor was chosen with a voltage rating of 25V.

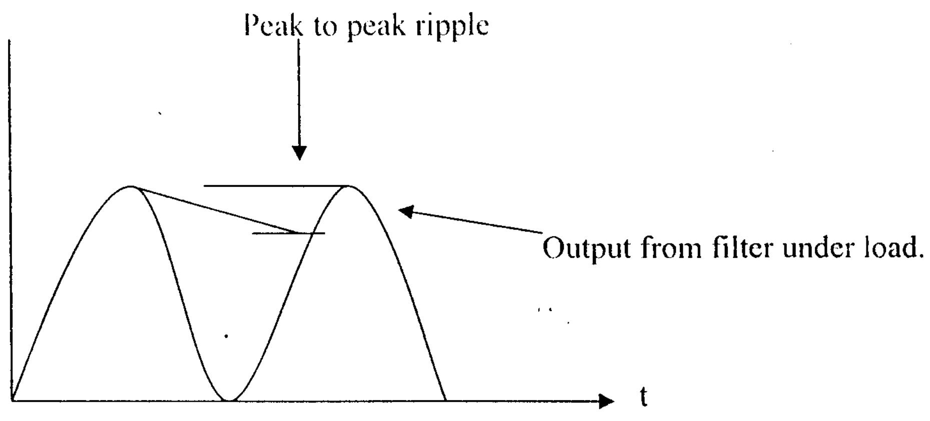


Fig.3.3 Output waveform of rectifier and filter

3.2.4 The regulator: The regulator section performs the function of giving a constant regulated Dc output from the rectified DC voltage input. The 7805 regulator is employed to give an output of 5V. This is due to the fact that most components in the circuit can be powered using a 5V DC supply.

A LED indicator is included in the power unit to indicate power supplied to the circuit.

3.3 THE ALARM UNIT

This unit is also divided into sub units or sections as shown in the block diagram.

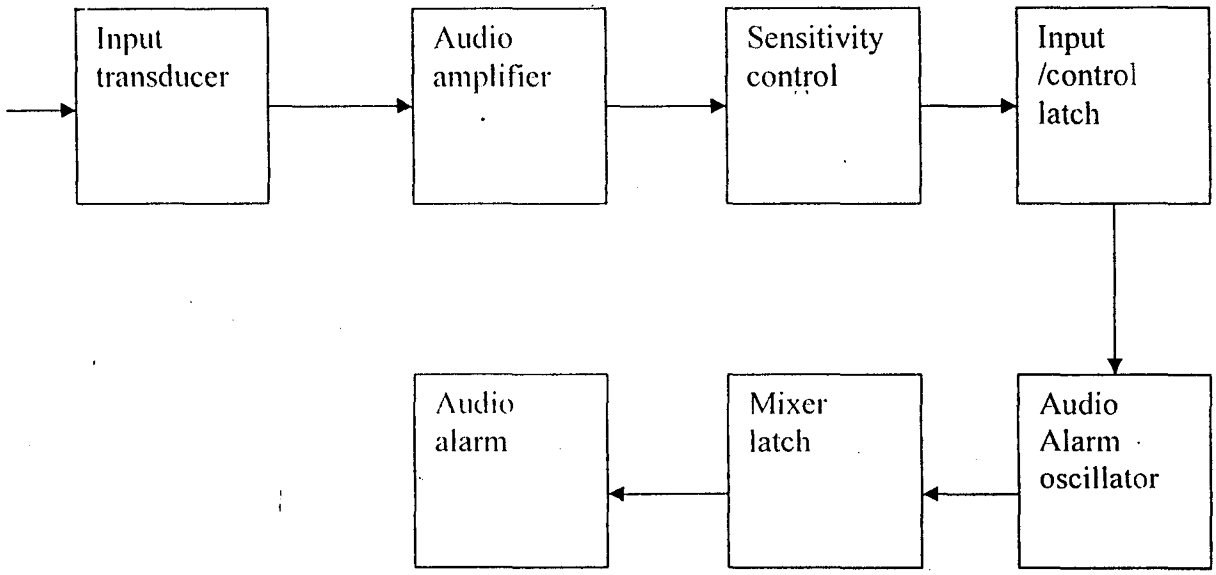


Fig.3.4 Block diagram of the alarm circuit.

The operation of this unit starts with the input transducer, which receives sound input from the environment and converts it into electrical signals. These signals are amplified by the audio amplifier in the second section. Two variable resistors form the sensitivity control. These resistors can be adjusted to regulate the sensitivity of the input transducer. The 4^{th} section is the input/control latch, which maintains a signal sent to it in order to keep the alarm ringing. Once there is a signal input the latch transfers this to its output and maintains this output state until the reset button is pressed. The oscillator receives the output from the latch and produces two outputs at pins 3 and 6 (one at higher frequency than the other). The outputs of the oscillator are combined by the mixer latch to give a desirable alarm signal.

Each sub-unit is discussed in detail below.

3.3.1 The input transducer: A transducer is a device, which converts one form of energy to another. In this design it is desired that sound energy be converted into electrical energy, which will be used in the circuit. The transducer employed to achieve this is a microphone.

3 basic properties must be considered when choosing a microphone.

Impedance: This is total opposition to alternating current and it is important that this is closely matched to the input impedance of the amplifier it is being used with for efficient power transfer.

Directional sensitivity: This is the responsiveness to sound coming from different directions. A microphone may produce larger voltage output for sound coming from certain directions than sounds coming from other directions.

Frequency response: This should cover the range of20Hz to 16.5KHz, which is the audio frequency range. In addition the microphone sensitivity should be the same for all frequencies within the same range.

With these three properties in mind the 600ohm unidirectional moving coil microphone was used. An added advantage if this microphone is that it can be used at the end of a considerable length of cable without the need of amplifiers, being a moving coil microphone [2].

3.3.2 The amplifier stage: This section is built around an LM386 CMOS operational amplifier. This section performs the function of amplifying the signal from the microphone to up to 200 times the original value.

The LM386 performs this task when connected as in the circuit diagram below.

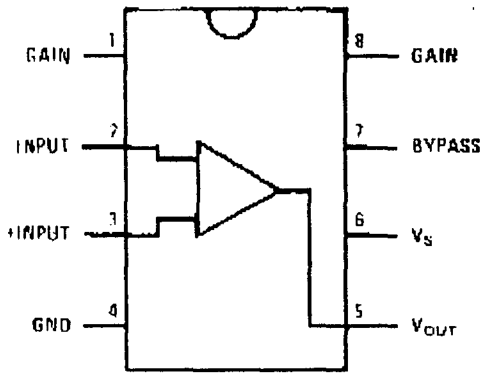


Fig.3.5 Schematic connection of the LM386

The LM386 CMOS operational amplifier has the following properties:

1. Battery operation
2. Minimum external parts
3. Wide supply voltage range
4. Low quiescent current drain (4mA)
5. Voltage gain from 20 to 200
6. Ground referenced input
7. Available in 8pin MSOP package.

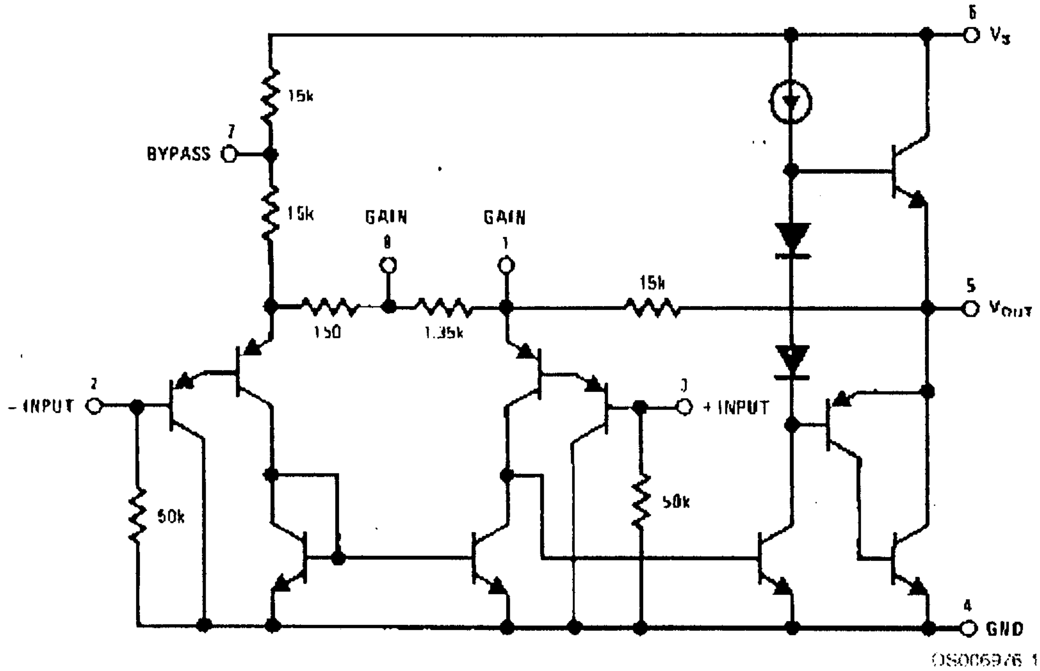


Fig3.6 Internal circuitry of the LM386

3.3.3 Sensitivity control: This section performs the function of varying the sensitivity of the microphone to sound inputs. This is achieved through the use of two variable resistors (2Kohm and 1Kohm). Increasing the resistance decreases the sensitivity of the microphone and vice versa.

3.3.4 The latch stage: This section receives the amplified signal from the amplifier and maintains the signal until the reset button is pressed. This ensures that the alarm keeps on ringing until attention is drawn.

This section is built around the CD4013B CMOS dual type flip flop. The CD4013B dual type flip flop is a monolytic complementary metal oxide semiconductor (CMOS) integrated circuit constructed with N and P channel enhancement mode transistors.

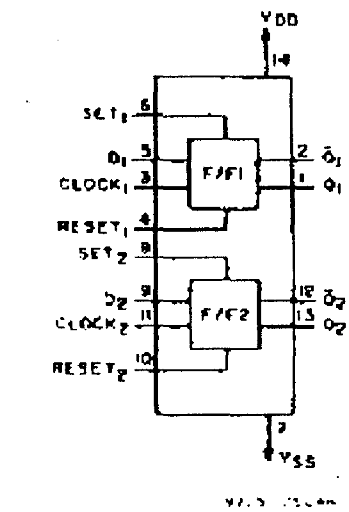


Fig.3.7 Functional diagram of the CD4013B

Flip flops are basically memory circuits. They have the ability to remember previous occurrence. Once triggered and a low signal is applied at both the RESET and SET inputs the flip flop maintains the previous state of the output until the set input goes high. Only one flip flop is used in this design. The reset button is thus connected to pin 6.

Some features of the CD4013B include:

1. Wide supply voltage range

2. High noise immunity (typically 0.45VDD)

3. Low power TTL [3].

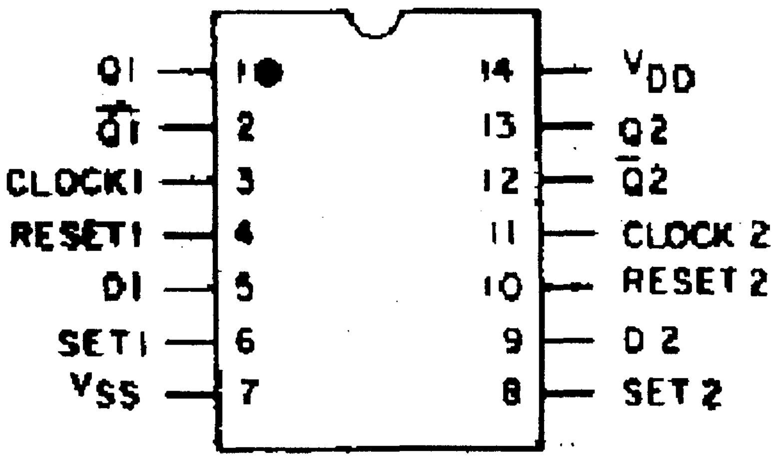


Fig3.8 Terminal assignment of the CD4013B

3.3.5 The oscillator stage: The output from the collected at this stage by the oscillator, which produces 2 outputs at different frequencies.

The oscillator design is built around the CD4060B CMOS integrated circuit. The CD4060B is a 14-stage ripple carry binary counter. The counters are advanced one count on the negative transition of each clock pulse. The counters are reset to zero state by a logical 1 at the reset input independent of the clock [4].

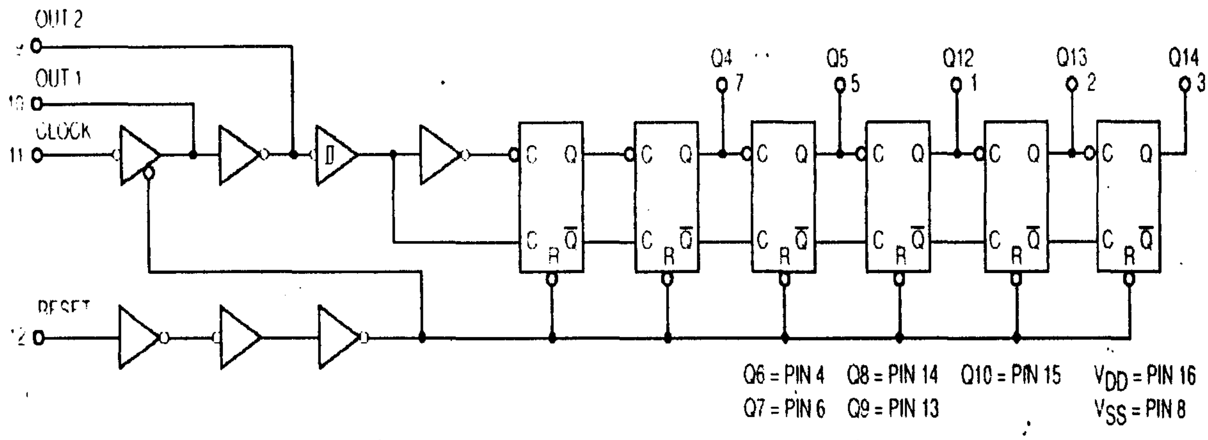


Fig.3.9 Logic diagram of the CD4060B

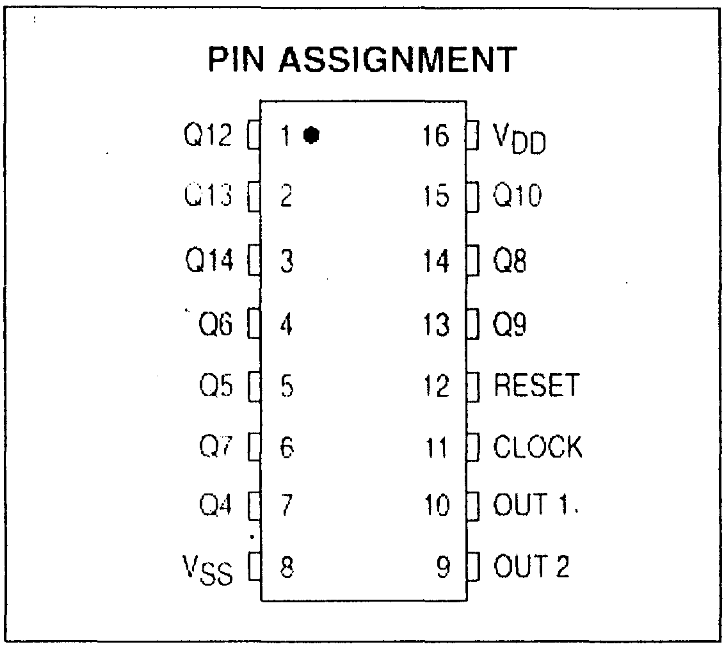


Fig.3.10 Pin assignment of the CD4060B

Some features of the CD4060B include:

1. Wide supply voltage range

2. High noise immunity

3. Low power TTL compatibility

4. Medium speed operation (8MHz typically at VDD= 10V)

5. Schmitt trigger clock input.

For the oscillator design the following were implemented:

R2 = 2*R1 to 10*R1 , considering this a value of 33kohm was used for R1 and 100Kohm for R2.

$$2.f = \frac{1}{2.3*R1*C1} = \frac{1}{2.3*33000*0.001\mu} = 13.2khz$$

$$f1(f\ pin3) = \frac{13.2k}{2^{14}} = 0.8057Hz$$

$$f2(f\ pin6) = \frac{13.2K}{2^{7}} = 103.125Hz$$

F1 and F2 are the frequencies of the output of the oscillator.

3.3.6 Mixer latch: At this stage the outputs from the oscillator are mixed (combined) to produce an alarm signal which goes high and then low repeatedly. This section is built around a 4013B CMOS dual type flip flop.

3.3.7 The audio alarm: This is the output stage and consists of the speaker circuit and its transistor driver. The siren circuit is designed using an 8ohm, 1watt speaker driven by a 2SD400 transistor. The output from the mixer latch is connected to the speaker.

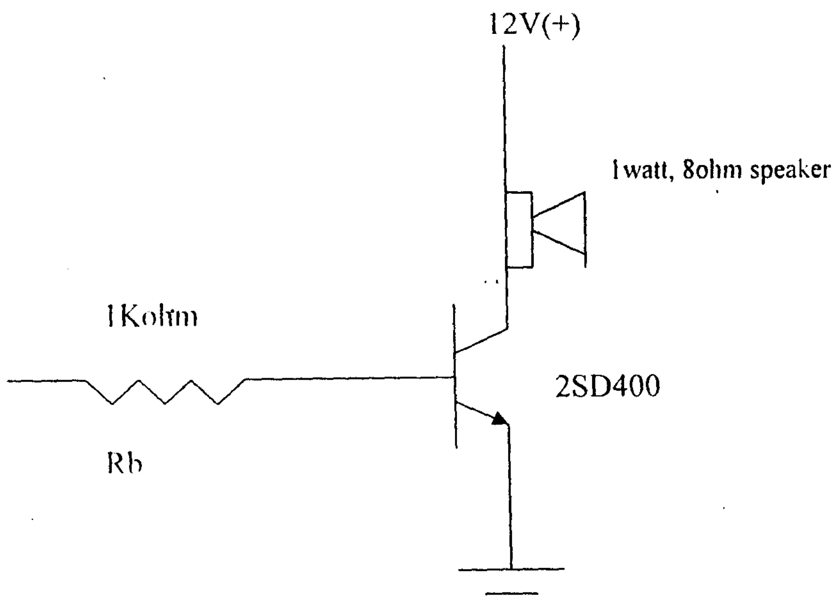
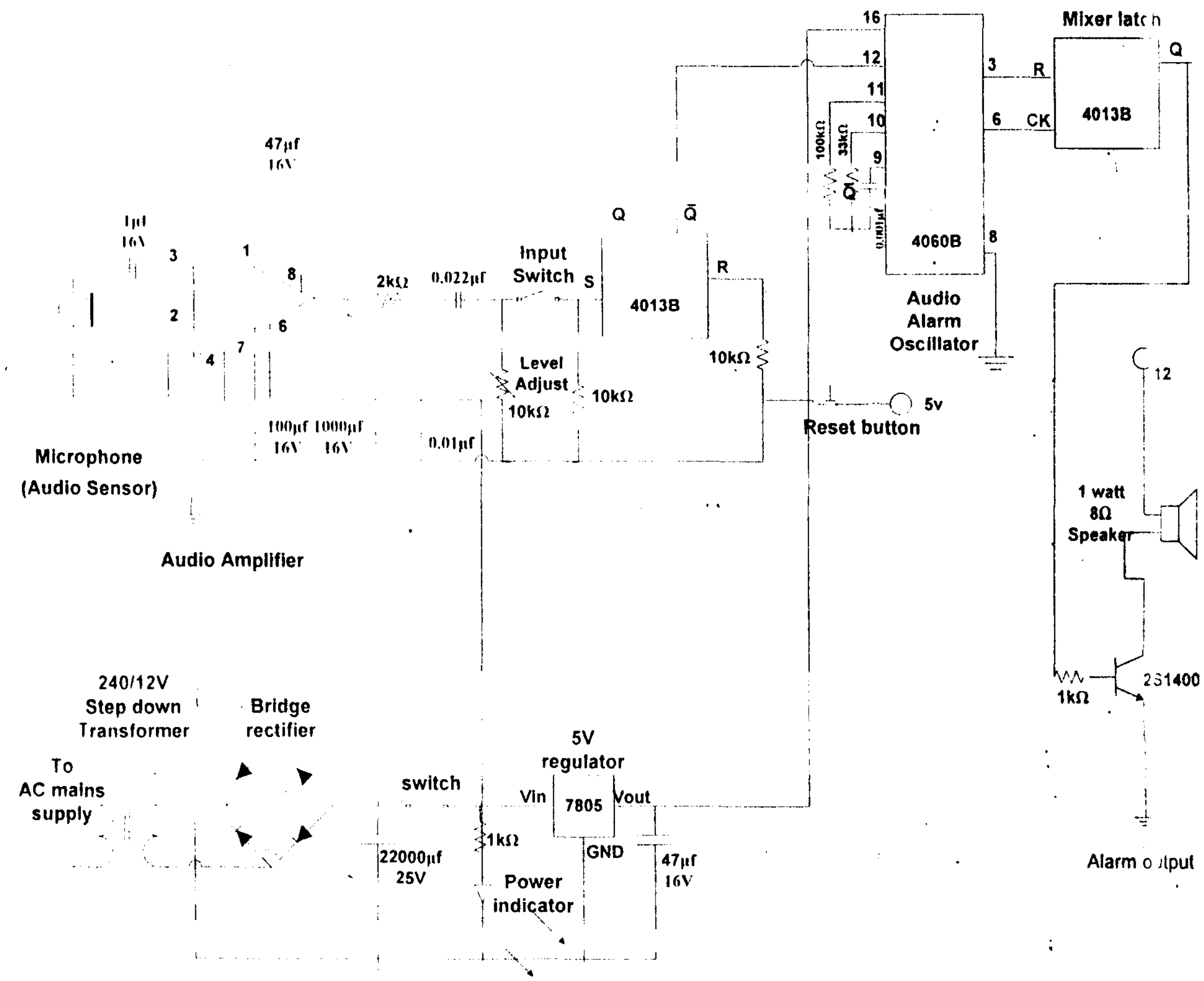


Fig. 3.11 Connection of the Alarm output



CIRCUIT DIAGRAM OF A SOUND ACTIVATED ALARM

Fig. 3.12. Circuit Diagram of a Sound Activated Security Alarm

CHAPTER 4

CONSTRUCTION AND TESTING

4.1 CONSTRUCTION

The sound activated burglar alarm circuit was first simulated on multism electronic workbench to ascertain its functionality. All components were then mounted on a vero board as in the circuit diagram.

The power supply unit was first constructed on the vero board since the flow of current into the circuit is the first step towards achieving any positive results.

The components were positioned on the board by poking their leads through the holes from the opposite side of the copper tracks. All components were placed before soldering. This permits better judgment and connection linkage between the components.

Integrated circuits were inserted into IC sockets to prevent damages to the ICs.

The construction was carried out using the following equipment

1. Soldering iron
2. Sucker
3. Soldering lead

4. Digital multimeter.

For the construction the following components were used.

1. 220V/12V, 500mA transformer

2. Plug and cord for connection to AC mains
3. Switch for mains
4. Diodes for rectifier
5. 7805 regulator
6. Red LED for power indicator
7. Matrix board
8. Microphone (unidirectional 600ohm impedance)
9. Variable resistors:(a) one, 2Kohm, (b) one, 10Kohm
10. Resistors: (a) two, 10Kohm, (b) two, 1Kohm, (c) one 33Kohm, (d) one, 100Kohm
11. Capacitors: (a) 100μF, 16V, (b) 1000μF, 16V, (c) 1μF, 16V, (d) two, 47μF, 116V, (e) 2200μF, 25V,(f) ceramic, 0.01μF, (g) ceramic, 0.022μF, (h) ceramic, 0.001μF
12. 4, IN4001diodes
13. Integrated circuit chips : (a) LM386 low signal amplifier,

    (b) 2, CD4023B dual type flip flop, (c) CD4060B ripple carry binary counter.
14. One loudspeaker 8ohm, 1watt.

15. One 2SD400 transistor

16. Copper wires

4.2 PROJECT CASING

The entire circuit is housed in a black plastic casing for the major reasons of resistance to stain and portability.

Appropriate holes were made on the casing for power cable, switch, power LED, and reset button. Holes were also made at the side close to the transformer to provide ventilation.

4.3 TESTING OF THE CIRCUIT

The testing of the circuit was done at every stage of the construction with each block tested individually.

The power supply unit was tested using the digital multimeter. A power off test was carried out to test for continuity and power on test to check the output voltage level at the transformer and regulator. This unit functioned well when tested.

The output voltage of the amplifier stage was checked using the multimeter. The amplifier was thereafter connected to the speaker via a 47μF capacitor and tested for output sound from the microphone.

The entire circuit was connected and a sound of high intensity made. The siren sounded to confirm proper functioning of the latch and oscillator stages.

The sensitivity of the microphone was varied using the two variable resistors and a variation was noticed in its response to sounds for each setting of the variable resistors. A standard setting was settled for with the following response to different sounds at different distances.

Table 4.1 Alarm sensitivity for different sound intensities

ACTIVITY	MAXIMUM DISTANCE (cm)
Snapping of fingers	10
Clapping of hands	100
Banging of a door	300

From the results tabulated above it is obvious that this design will excel in the environments it is specified for. At an increased sensitivity the alarm can sense slight movements within 4-meter radius.

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

The aim of this project right from conception is to produce an alarm output on a speaker from sound inputs picked up at the input.

After considerable time spent on analysis, design, and construction a final product was arrived at which was tested with the following results.

Table 5.1 Alarm sensitivity for different sound intensities

ACTIVITY	MAXIMUM DISTANCE (cm)
Snapping of fingers	10
Clapping of hands	100
Banging of a door	300

From the results above and considering the added advantage that the sensitivity of the microphone can be varied, the above is achieved.

The entire project is therefore a huge success.

5.2 PROBLEMS ENCOUNTERED

In the course of this project the following setbacks were encountered.

1. Erratic power supply, which considerably slowed down the pace at which the work was carried out.
2. Unavailability of components at close proximity.
3. Due to time constraints some attractive features could not be added to the project such as light alarm and battery alternative for power supply.

5.3 RECOMMENDATIONS

This project like every other engineering work is not without room for improvements.

A light alarm can be incorporated to act as added signal in dark environments.

A radio based transmitter and receiver circuit connected to both the microphone and the other parts of the alarm could be incorporated. This would enable the microphone to be separated from the rest of the circuit. The microphone can therefore be placed in the area to be protected and the alarm circuit placed at another location where the sound would be heard. This also provides a certain level of portability.

A multi channel amplifier with connections to several speakers can also be introduced to provide alarm signals at different locations.

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